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(54) [Title of the Invention] Drive arrangement including internal combustion engine which generates torque with speed fluctuation rate

[Abstract] To reduce a speed fluctuation rate of an internal combustion engine (1), an output current (I2, $\dot{I}2$) of a dynamometer (7) is controlled in dependence on a crank angle such that the dynamometer (7) forms a load dependent on the crank angle which counteracts with the speed fluctuation rate of the internal combustion engine (1). (32 30 697)

[Claims]

[Claim 1]

A drive arrangement particularly for an automobile, which includes an internal combustion engine that generates torque with a speed fluctuation rate and a dynamometer, particularly a cell dynamometer, a rotor of the dynamometer being connectable to an output shaft of the internal combustion engine without slipping, and forming a component part of a flywheel for the internal combustion engine in particular, characterized in that:

an output current (I2, $\dot{I}2$) of the dynamometer (7) has a characteristic dependent on a crank angle, and makes the rotor (5) generate a load torque (M, $\dot{M}$) which counteracts with the speed fluctuation rate for the internal combustion engine (1).

[Claim 2]

The drive arrangement according to claim 1, characterized in that the internal combustion engine (1), and the dynamometer (7) and a regulator (25) for the output current (I2, $\dot{I}2$) or excitation current (I1, $\dot{I}1$) of the dynamometer (7), are arranged as a control subject and an actuator, respectively, in a control circuit for a control amount (ω) which reproduces a rapid change of a crank shaft rotation speed.

[Claim 3]

The drive arrangement according to claim 2, characterized in that the control amount is an angular acceleration (ω) (when a clutch (3) is provided between the internal combustion engine (1) and the flywheel (4)).

[Claim 4]

The drive arrangement according to claim 3, characterized in that the control circuit includes a rotation speed sensor for detecting an angular velocity of the rotor (5) and differential means (22) for obtaining a signal which represents an angular acceleration (ω) of a given time.

Drive arrangement including internal combustion engine which generates torque with speed fluctuation rate

[Detailed Description of the Invention]

The present invention relates to a drive arrangement as claimed in the preamble of claim 1. The present invention relates particularly to a drive arrangement including a cell dynamometer as disclosed in German Patent Application Laid-Open No. 29 25 675. As disclosed, the cell dynamometer is sandwiched between two clutches, thereby being arranged so as to be able to be disconnected from a transmission connected to the rear thereof and also from an internal combustion engine connected to the front thereof. The cell dynamometer is used as a generator for generating electric energy, namely, for charging an on-board battery, and also as a starter for the internal combustion engine. Such construction offers an advantage, in particular, that a mass of a rotor of the cell dynamometer is utilized as a component part constituting a mass of a flywheel which has a role of reducing a speed fluctuation rate of torque generated by the internal combustion engine as is known. Such a known construction method provides an excellent operational reliability through avoidance of current supply to the rotor. This is because a coil of the cell dynamometer is housed within the starter as a field coil for supplying direct current and also as a coil of the generator and the motor, and thus, there is no coil in the rotor.

To reduce the speed fluctuation rate caused by the amount of various disturbance which is difficult to eliminate individually with ease, such as a change in the composition of air-fuel mixture of the internal combustion engine, and fluctuation in a rotation speed and a peak pressure within a combustion chamber, in addition to an ignition sequence of the internal combustion engine, a mechanical device such as a flywheel as mentioned above or other mechanical auxiliary means that operates according to the principle of inertia is generally used. However, particularly when

there is a small number of combustion chambers in the internal combustion engine, sufficient reduction in the speed fluctuation rate can not be achieved without expending considerable cost.

The speed fluctuation rate is understood as a ratio of a mean angular velocity to a derivative of maximum angular velocity that appears.

It is an object of the present invention to obtain a drive arrangement as claimed in the preamble of claim 1 by which an effective reduction of a speed fluctuation rate is achieved by a mechanical additional cost that is practically negligible.

Measures for achieving the aforementioned object according to the present invention consists of each characteristic claimed in the characterizing portion of claim 1.

That is, it can be regarded that a main advantage of the present invention is that a device that is provided in any case, namely, a dynamometer or a cell dynamometer, is utilized not only to obtain the flywheel mass, but also to repress the speed fluctuation rate by an electromagnetic system, that is, to eventually achieve a counter torque dependent on a crank angle. In this case, a publicly known fact that a torque of the dynamometer that applies a load to the internal combustion engine is a function of dynamometer power generated, and furthermore, the dynamometer power itself can be controlled by, for example, field current of the dynamometer, or by way of a semiconductor switch in the case of permanent excitation, is utilized.

A preferred embodiment and a configuration example of the present invention are subject to dependent claims. An embodiment according to claim 3 has a great significance in a case in which no attribution relation, that is faithful to the angle, is established at all between an output shaft (crank shaft) of the internal combustion engine and a rotor shaft by, for example, disposing a clutch between the internal combustion engine and the dynamometer rotor. However, in any case, to transmit a counter torque generated by the dynamometer to the output shaft of the internal combustion engine, a connecting portion with no slipping (of a clutch or toothed belt) should be provided between the two devices.

Next, an embodiment of the invention will be described with reference to the accompanying drawings.

Fig. 1 is a schematic diagram of a drive arrangement including a cell dynamometer, that is based on a principle of a drive arrangement according to the aforementioned German Patent Application Laid-Open No. 29 25 675 and is provided with a characteristic of such drive arrangement.

Fig. 2 shows a measure for reducing a speed fluctuation rate according to the present invention.

An internal combustion engine 1 which drives a drive wheel of an automobile assumed in this case, is connected with a coil-less rotor 5 of a cell dynamometer 7 via a clutch 3 at the downstream side of an energy flow. The rotor 5 forms a component part of a flywheel 4. The cell dynamometer 7 further includes a stator 6. The flywheel 4 can be connected with a transmission 9 via another clutch 8. Furthermore, the transmission 9 is designed to drive the drive wheel 2 via a differential 10.

That is, all coils of the cell dynamometer 7 are arranged in the stator 6, and only end portions 11 and 12 of the coil are shown in Fig. 1. Reference symbol I1 denotes excitation current, and reference symbol I2 denotes generator current. The generator current is utilized to charge a battery 13. When a direction of current changes (as shown by a broken arrow in Fig. 1), the current is the motor current which exists during operation of the starter.

The flywheel 4 further includes a sprocket 14. Respective teeth of the sprocket 14 are lined at equal intervals. Accordingly, by a general method that utilizes an electromagnetic sensor 15, a signal representing a rotation speed n of a given time that is in proportion to an angular velocity of the flywheel 4 and, if the clutch 3 is engaged, also to an angular velocity of a crank shaft 16 of the internal combustion engine, can be obtained. The internal combustion engine 1 generates a torque M. The following description is based on the assumption that the clutch 8 is disengaged.

As already defined in the above, a speed fluctuation rate appears as fluctuation in an angular velocity of the crank shaft 16 and the rotor 5, that is dependent on a crank shaft of a given time. Counteraction against such fluctuation is caused by a control circuit shown in Fig. 2. A subject of the control is the internal combustion engine 1 which is applied with the amount of disturbance including various air-fuel mixture compositions and various peak pressures in the combustion chamber as shown by arrows 20 and 21. The rotation speed n or an instantaneous value of angular velocity detected by the sensor 15 (Fig. 1) is sent to a differential member 22 to obtain the amount corresponding to the angular acceleration. The amount obtained is compared with a reference value 24 in a comparator 23. An output amount from the comaparator 23 which represents control deviation is sent to a controller 25. The controller 25 supplies field current I1 and I'1 to the cell dynamometer 7 which is an actuator of the control circuit via an amplifier 26. As a result, certain generator current I2 and I'2 is generated, and a certain load of the internal combustion engine 1 that is dependent on a crank angle and is given in the form of the torque M and M' is generated by the cell dynamometer 7. This load acts to eliminate the speed fluctuation rate.

As is obvious, time behavior of the actuator 7 should conform to that of the

control subject 1. The cost required for various measures according to the present invention is insignificant if a general microprocessor is used particularly for the control circuit, including detection of the control amount and setting of a reference value. The dynamometer or the cell dynamometer may employ a different operation principle. For example, a generator with a claw-type magnetic pole, a reluctance motor, or an asynchronous motor may be used. If a permanent excitation-type synchronous motor is used, current of the generator may be controlled by open-loop control or closed-loop control via a semiconductor switch. In either case, the present invention provides yet another advantage that appropriate adjustment is automatically made in accordance with the speed fluctuation rate present at a given time, compared with the means for reducing the speed fluctuation rate which operates based on the principle of inertia of a complete mechanical system.

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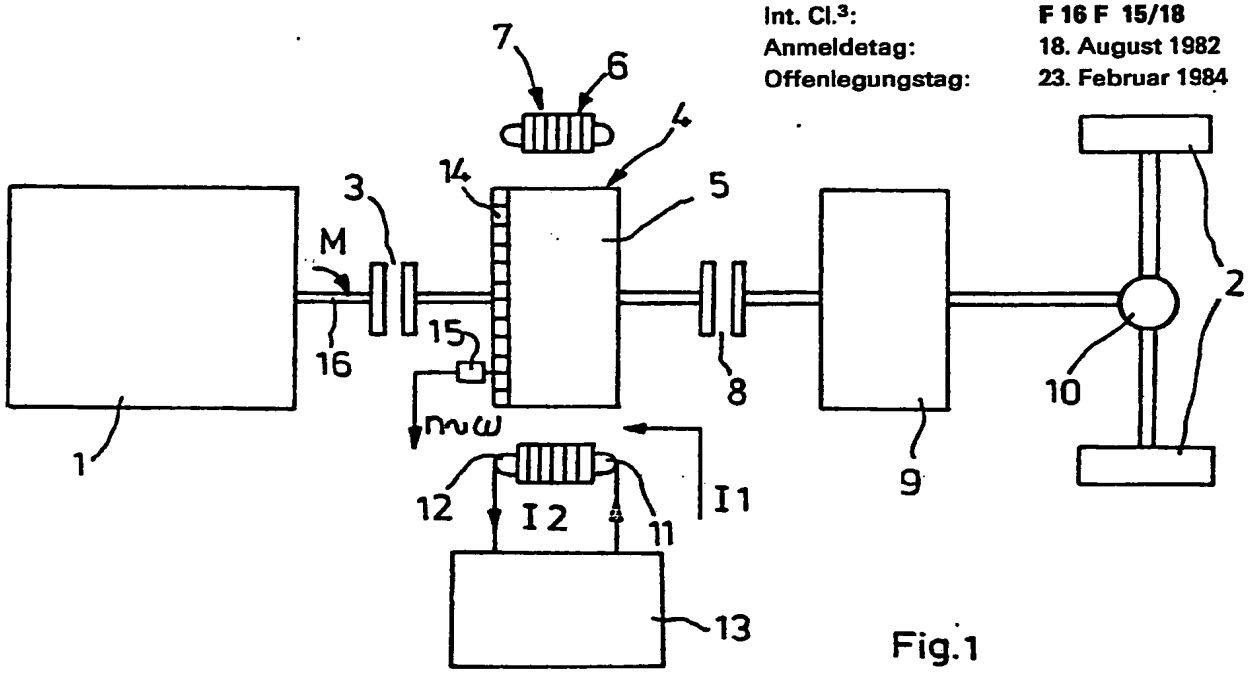

Fig.1

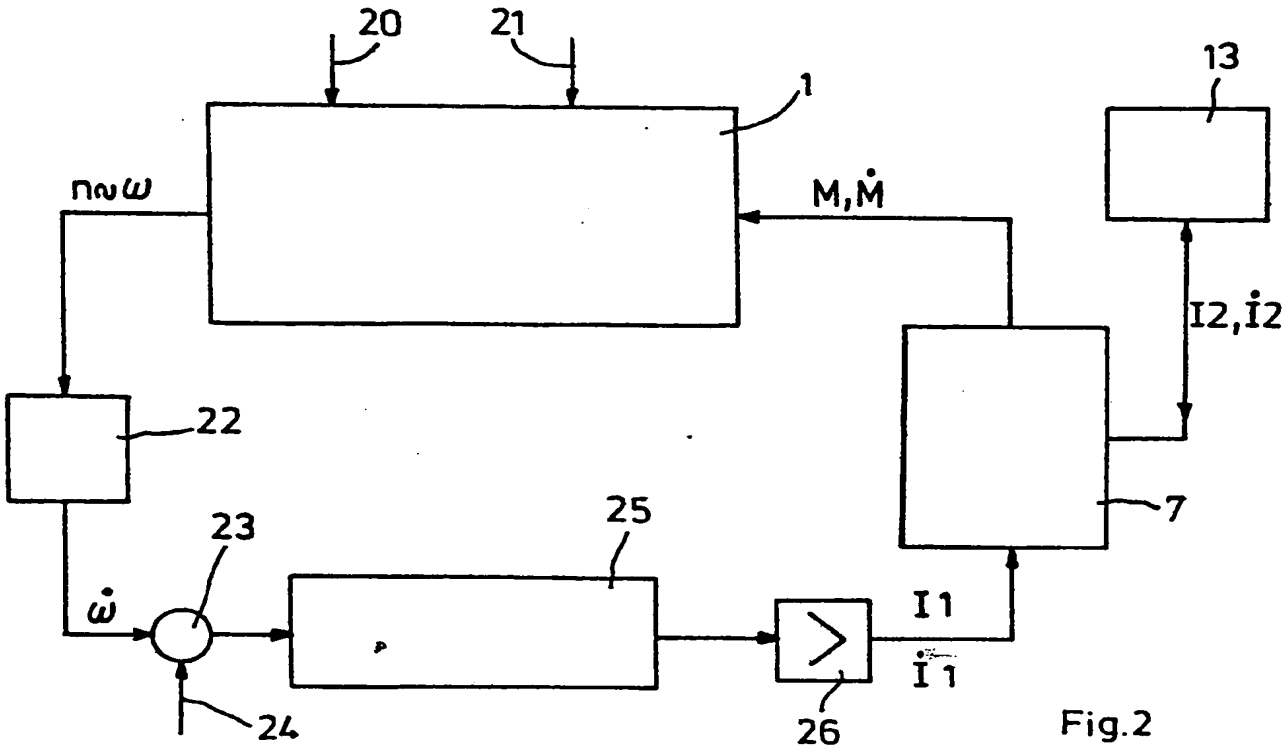

Fig.2

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